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FLEAS AND PLAGUE.

RECENT ADDITIONS TO OUR KNOWLEDGE OF THE MECHANISM BY WHICH FLEAS PROBABLY SPREAD THE DISEASE.

Because of the presence of plague in the ground squirrels of California and the rats of Seattle and Habana, the question of the manner of transmission of the infection is one of special interest to health officers who may at any time be called upon to combat the disease. Recently a report by A. W. Bacot and C. J. Martin, both of Lister Institute, appeared in the *Journal of Hygiene, Plague Supplement III*, Cambridge, 1914, giving the results of certain experiments carried on regarding the mechanism of transmission of plague by fleas. The experiments seem to add materially to our knowledge of the subject and probably to throw considerable light upon the previously noted, but not understood, seasonal prevalence of the disease in certain localities.

The following is essentially an abstract of the main features of the report:

From a study of the epidemiology of plague, the belief that the flea played an important rôle in the spread of the disease was advanced as early as 1897-98. In 1902-1904 it was quite conclusively shown by animal experimentation that the disease could be spread from rat to rat by this agency. It was also demonstrated that the puncture in the skin made by the flea in the act of feeding affords a wound through which it is possible for plague bacilli to enter, and animals were infected by the application of infectious material to areas on which fleas had been allowed to feed.

In its second report (1907) the Commission for the Investigation of Plague in India, in discussing the possible methods by which the flea may transmit plague, mentions that it may be "by a regurgitation of the stomach contents through the esophagus and pharynx, the bacilli being then injected with the saliva, or on the pricker, or being rubbed into the wounds made by the pricker." The commission, however, found that the infection could be conveyed by smearing recent flea bites with infectious blood or virulent cultures of plague bacilli and considered that the possibility of the transmission of infection among

rodents by rats rubbing flea feces into recent flea bites had been demonstrated. The commission, however, did not feel justified in expressing an opinion as to whether the rubbing of infectious feces in this way into recent flea bites was the usual method of infection.

Bacot and Martin repeated the experiments of the plague commission, and were able to infect rats by applying to a recently flea-bitten area the spleen from a plague rat, or a strong emulsion of plague bacilli from the stomachs of fleas which had been fed on plague-infected animals. While 9 out of the 10 rats to which spleen had been applied died of plague in less than three days, only 5 out of 23 rats to which the emulsion from flea stomachs had been applied died of plague. This suggested that the plague bacilli from the contents of fleas' stomachs had lost certain properties, with the result that they produced infection through flea bites less easily than bacilli from plague spleens.

The experiment was carried out of allowing fleas which had previously fed upon infected animals to bite fresh animals under such conditions that there was little probability of the punctures made in feeding becoming contaminated with infected flea feces. It was found that animals could thus be infected, although it was usually necessary for a considerable number of fleas to bite a rat, and only a relatively small proportion of the animals became infected in this way. The authors took this to show that infection may be conveyed by fleas during the act of feeding without fecal contamination of the wound, but that infection by no means occurs every time a flea with plague bacilli in its stomach feeds on a susceptible animal. However, when 20 fleas which had been shown to have plague bacilli in their feces were allowed to feed on each rat on two successive days, 9 out of 13 of the rats died of plague. The authors believed this indicated that the proportion of infection rises with the number of opportunities for infected fleas to feed upon the animal.

The authors found that in certain fleas which had fed upon infected animals, tenacious masses of plague bacilli had formed in the stomach and frequently occluded the lower end of the esophagus, with the result that while the flea could bite and suck blood into its esophagus, the blood could not get through the occluded part into the stomach. In this way the flea was unable to feed, although hungry and making repeated attempts. They also noticed that the blood in the distended esophagus, failing to enter the stomach, would frequently be regurgitated through the mouth upon cessation of the sucking act.

Fleas (*Xenopsylla cheopis*) in which the esophagi were occluded with these tenacious masses of plague bacilli were allowed to bite rats, one or two fleas being allowed to feed upon each rat on one or two, or sometimes three, days in succession. Of four rats used, all died of plague.

The authors summarized their work as follows:

Under conditions precluding the possibility of infection by dejecta it was found that two species of rat fleas, *Xenopsylla cheopis* and *Ceratophyllus fasciatus*, fed upon septicemic blood, can transmit plague during the act of sucking, and that certain individuals suffering from a temporary obstruction at the entrance to the stomach were responsible for most of the infections obtained, and probably for all.

In a proportion of infected fleas the development of the bacilli was found to take place to such an extent as to occlude the alimentary canal at the entrance to the stomach. The culture of pest appears to start in the intercellular recesses of the proventriculus and grows so abundantly as to choke this organ and extend into the esophagus. Fleas in this condition are not prevented from sucking blood as the pump is in the pharynx, but they only succeed in distending an already contaminated esophagus, and, on the cessation of the pumping act, some of the blood is forced back into the wound. Such fleas are persistent in their endeavors to feed, and this renders them particularly dangerous. Fleas suffering from obstruction do not necessarily perish, and in course of some days the culture obliterating the lumen of the proventriculus may autolyse and the passage again become pervious. They are, however, incapable for the time being of imbibing fresh fluid, and are, therefore, in danger of drying up if the temperature is high and the degree of saturation of the atmosphere low. Although, as far as our observations go, they withstand desiccation quite as well as normal fleas which are not fed, their length of life must be short directly hot, dry weather sets in, and we are led to wonder whether this fact may not, to some extent, explain why in India epidemic plague is confined to the cooler and moister seasons, and particularly why in Northern and Central India the epidemics are abruptly terminated on the onset of the hot, dry weather.

MORBIDITY REPORTS IN LOUISIANA.

An amendment was made to the Sanitary Code of Louisiana April 24, 1914, requiring physicians to report cases of notifiable diseases both to the State health officer and to the local board of health. These reports are to be made within 24 hours. The requirement insures that both the local and State health departments will receive prompt notice of cases and at all times have current information of the prevalence and geographic distribution of the controllable diseases.

Requiring reports to be made to both the local and State health departments is not at present a common practice in this country. It seems, however, to be necessary in States in which adequate provision has not been made for efficient local health officers under the control and supervision of the State health department.

SANITATION MISAPPLIED.

By ARTHUR M. STIMSON, Passed Assistant Surgeon, United States Public Health Service.

A popular reflection of the activities in recent years along public health lines is seen in the public exploitation of the adjective "sanitary." At every turn we encounter "sanitary" groceries, bakeries,